Advanced Processing for Photonics Manufacturing

Mehrdad Ziari and Scott DeMars
SDL, Inc.

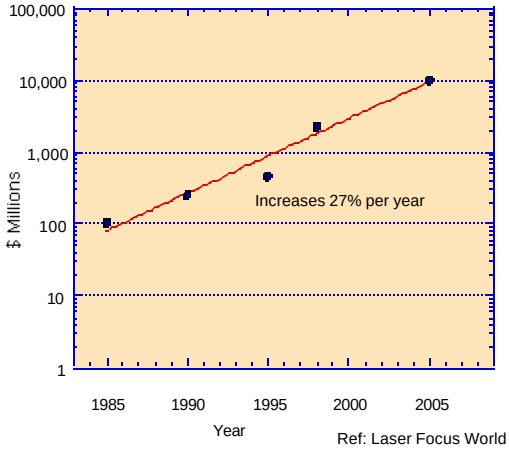
1999 ATP National Meeting

Outline

- Project Objective and Motivation
- Team
- Project Background and Technical Information
- Role of ATP

Why Automation?

Semiconductor Laser Business Growth



Ref: Laser Focus World

Motivation

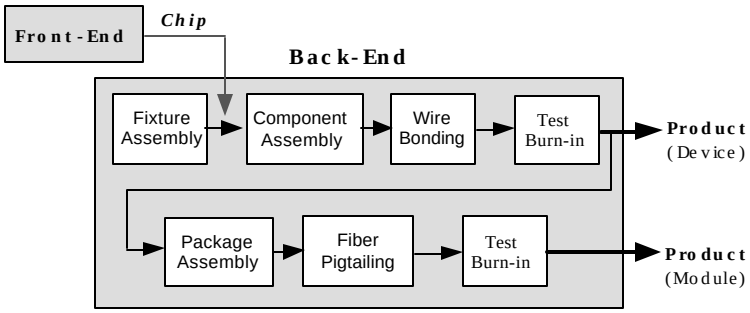
Chip → Assembly → Packaging

- Chip manufacture is already performed as a high volume batch process with improving process control, but...
- Chip design greatly influences assembly and packaging yield and tolerances
- Assembly and packaging dominate cost
  - Highly yield sensitive due to value added in the process
  - Long qualification and burn-in screening time make process control a critical necessity
  - Throughput and high density of parts in test needed to meet capacity demands

Assembly Automation

- Process automation is key
  - Device design and wafer fabrication
  - Assembly & Packaging
- The joint venture team will build an integrated robotics assembly and testing line that can handle, accurately position and test fragile optical components

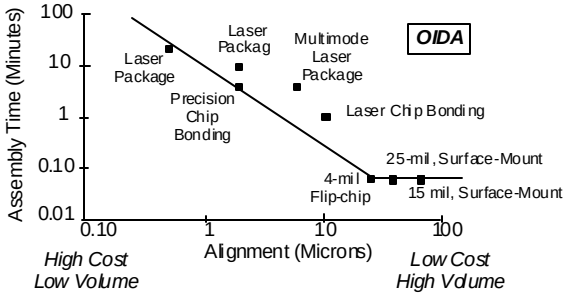
Device Assembly



Barriers for Advanced Photonics Assembly

- Requirements cannot be met by standard Si tools.
  - Extremely fragile parts
  - low damage threshold and lengthy failure mode analysis cycle
  - Small parts & tight tolerances (~ µm)
    - optics, lasers, fiber.
- Suitable automation tools are not commercially available
- Semi-manual and labor intensive assembly.
- Costly packaging process.
- Expensive devices.

Assembly Time and Cost



Source: Fig. 3.6 of OIDA Technology Roadmaps for Optoelectronics

s

Project Objective

– Develop new automation, assembly, lasers and other technologies to enable automated batch processing of integrated optoelectronics devices, leading to substantial reductions in packaging and testing costs and time to market.

s

Project Team

Company	Core Business	Program Role	Size
RSoft	Photonics design software	Development of an advanced design tool	Small
Adept	Robotics and Automation	Development of high precision processes	Medium
Newport	Supplier of test & measurement systems	Test and Burn-in systems, system integrator	Medium
SDL	Manufacturer of photonics components	Team leader, automated assembly and test end-user	Medium

Project Summary

- Joint venture led by SDL, Inc. to develop new technologies for automated batch processing that could substantially reduce manufacturing costs and time to market for many optoelectronic devices while also increasing yield.
- Duration: 3 years (1/15/99-1/15/2002)
- Total funds: $ 5.83 M ($2.86 M ATP)

SDL, Inc.

- Products:
  - pump laser products
  - high power lasers for printing and material processing
  - fiber laser and amplifier systems
  - $LiNbO_3$ optical modulators (+ 10 Gb/sec)
- Size: about 1000 people, 106 M Revenue in ‘98

s

SDL, Inc.

- Started in 1983 to commercialize Xerox high power laser technology
- First major customer was satellite communications
- Until 1992 markets were heavily Research, Military and Space
- Today strategic focus is on OEM commercial markets of communications, power delivery/materials processing and printing

s

RSoft Inc.

- Current Products:
  - *BeamPROP* - **Photonic device simulator (BPM based)**
  - *LinkSIM* - **Fiber optic Link-Level simulator**
  - *FullWAVE* - **Photonic device simulator (FDTD based)**
- Size:
  - Privately owned small business
- History:
  - Established in 1990; Pioneer in optoelectronics CAD since 1994, with the introduction of *BeamPROP*

Newport Corporation

s

Leading Global Supplier of

High-precision Optics,
Instruments,
Micropositioning and
Measurement Products and Systems

To The

Fiber Optic Communications,
Computer Peripherals,
Semiconductor Equipment, and
Scientific Research Markets Worldwide.

6 January, 2000

s

Overview of Adept Technology

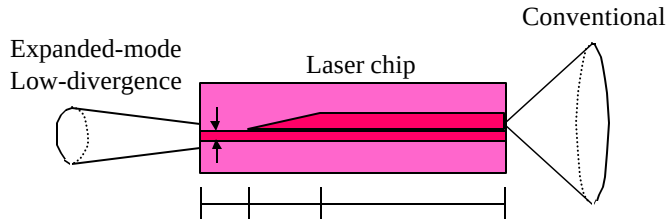
- Founded 1983
- Largest domestic maker of automation equipment and software: > 15,000 robotic systems worldwide
- FY 98 -- $98 M revenue, 425 people
- Products include: system software, motion controllers, sensing systems, material-handling equipment, and modular, scaleable robots
- Customer industries: electronics, pharmaceutical, appliance, telecommunications, food processing, and automotive components

6 January, 2000

Summary of Wafer Fabrication Approach

- Small laser mode size is the root cause of tight alignment tolerances in laser packaging.
- A laser with an expanded beam shape will be used as a means of relaxing the alignment tolerances, which are normally very tight, for optical fibers and lenses.
- Simulation tools will be developed by RSoft to model laser designs.

Tapered Chip Design



S

RSoft's Role:

Development of an advanced laser design tool

Laser designs	• F-P cavities • DFB cavities
State-of-the-art theoretical model	• Gain model for arbitrary QW profile • Current spreading • Quantum carrier heating • Spectral hole burning
Advanced user interface	• Parametric CAD interface • 3D device layout • Selection of output options
Full range of simulation results	• Static and dynamic behavior • Kink and Temperature sensitivity • L-I, I-V, Spectrum, Far-field, Frequency response

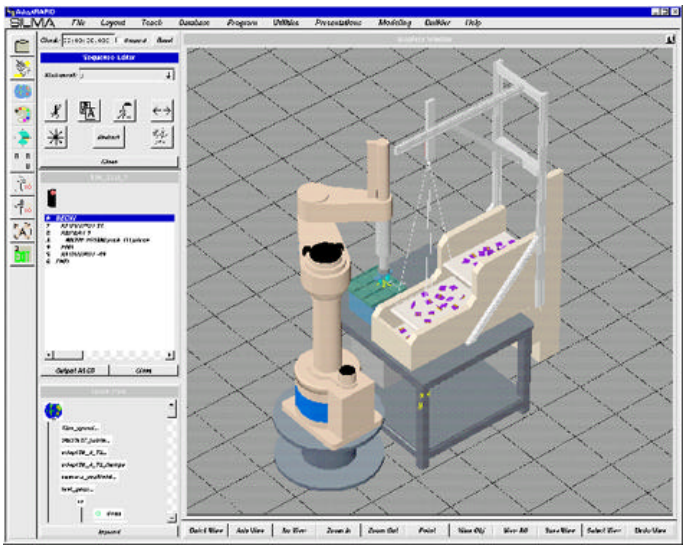
S

Adept's Role:

Development of high precision processes

Research	• Handling and feeding of micro and mille components • Improve cartesian robot precision performance • Advanced tooling and end effector design needed for die bonding
Develop	• Robot compatible with batch processing and tooling
Integrate	• Next generation controls • Precision assembly robot • Enhanced die bonding techniques

Example of Manufacturing Automation Design

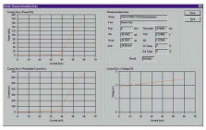


6 January, 2000

Newport's Role:

Development of test and burn-in systems, system integration

Fixturing	• Custom fixtures that allow placement and testing of 10 to 100 laser diodes
Hardware	• Test capability for performance validation of lasers used in DWDM applications
Software	• Data aquisition, logging and tracking of multiple devices in multiple fixtures • Add graphical representation of new measurements (wavelength characteristics • Interface with robotic load/unload system



6 January, 2000

Test Automation Platforms

- **Newport has become the established leader in LD T&M Systems…...**
  - **Broadest Product Range**
  - **Active and Passive Devices**
    - **….from burn-in to final test**
  - **Installations Worldwide**
  - **Dedicated Engineering, Applications and Service Support team in San Luis Obispo, CA**

AutoBar

LD Burn-in and Characterization

Factory Assembly and Test

6 January, 2000

SDL's Role:

Team leader, automated assembly and test end-user

Manufacturing inputs	• Establish automation requirements • Define specifications for each process • Coordinate a plan for tool development
Tool development	• Participate in tool design reviews • Provide custom subsystems
Verification	• Test tools to refine tools and processes • Establish suitability of tools for integration
Integration	• Provide a path to integration of automated processes • Implement tools in manufacturing

6 January, 2000

Role of ATP

- The ATP funding will enable the team to pursue parallel development of an integrated set of path-breaking technologies instead of individual projects on lower-risk elements of this concept.
- If successful, the project will lead to order-of-magnitude reductions in the costs of photonics components with significant potential saving for U.S. photonics industry.
- The new technology will have broad applications in telecommunications, information and sensor technology and health care.

6 January, 2000

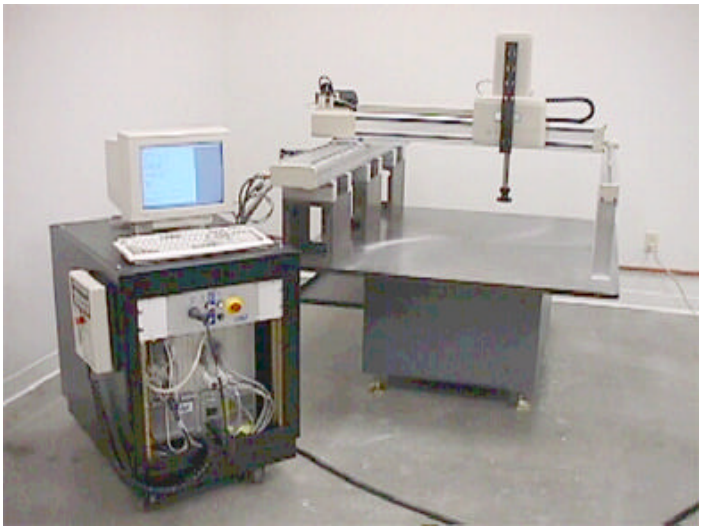
Role of NIST Co-investment

- Requires an integrated team effort
- The pay-off will be broadbased
- Will benefit from other NIST-supported activities.

6 January, 2000

Adept Robot

s



6 January, 2000

s

Conclusion

SDL, Inc	**Newport Corporation**	**Adept Technology**	**RSoft, Inc.**
80 Rose Orchard Way San Jose, CA 95134	720 Aerovista Place, Suite A San Luis Obispo, CA 93401	150 Rose Orchard Way San Jose, CA 95134	2000 Executive Blvd, Ossining, NY 10562
Mehrdad Ziari Ziari@sdli.com	John Koenig jkoenig@newport.com	Carl Witham Carl.Witham@adept.com	Robert Scarmozzino rob@rsoftinc.com
(408) 943-4338	(805) 544-8142	(925) 371-2591 ext. 311	(914) 734-2665

6 January, 2000